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## **Kennedy's Biomedical Laboratory Makes Multi-Tasking Look Easy**

**By Carol Anne Dunn**

If it is one thing that Florida has in abundance, it is sunshine and with that sunshine heat and humidity. For workers at the Kennedy Space Center that have to work outside in the heat and humidity, heat exhaustion/stroke is a real possibility. It might help people to know that Kennedy's Biomedical Laboratory has been testing some new Koolvests™ that can be worn underneath SCAPE suits. They have also been working on how to block out high noise levels; in fact, Don Doerr, chief of the Biomedical Lab, says, "The most enjoyable aspect is knowing that the Biomedical Lab and the skills of its employees have been used to support safe space flight, not only for the astronaut flight crew, but just as important for the ground processing personnel as well."

### **A Resource for Biomedical Research**

The NASA Biomedical Laboratory has existed in the John F. Kennedy's Operations and Checkout Building since the Apollo Program. The primary mission of this laboratory has been the biomedical support to major, manned space programs that have included Apollo, Apollo-Soyuz, Skylab, and Shuttle. In this mission, the laboratory has been responsible in accomplishing much of the technical design, planning, provision, fabrication, and maintenance of flight and ground biomedical monitoring instrumentation. This includes the electronics in the launch flight suit and similar instrumentation systems in the spacecraft. (Note: The Lab checked out the system for STS-128 at Pad A using Firing room 4 and ground support equipment in the lab.)

During Apollo, there were six engineers and ten technicians in the facility. This has evolved today to two NASA engineers and two NASA technicians, a Life Science Support contract physiologist and part-time support from an LSSC nurse and physician. Over the years, the lab has enjoyed collaboration with outside agencies and investigators. These have included on-site support to the Ames Research Center bed rest studies (seven years) and the European Space Agency studies in Toulouse, France (two years). The lab has also actively collaborated with the US Army Institute for Surgical Research, the USAF School of Aerospace Medicine, and the USN Naval Experimental Diving Unit. Because the lab often evaluates various forms of commercial-off-the-shelf life support equipment, the laboratory works closely with private companies, both domestic and foreign. The European companies seem to be more proactive and participatory with the advancement of personal protective equipment. Because these companies have viewed the space program's unique need for advanced forms of personal protective equipment, some have responded with new designs based on the prediction that these advances will soon find markets in the commercial sector.

Using much of the same skills and equipment, the laboratory also addresses physiological testing of humans by supporting flight experiments and personnel involved with ground processing. While Johnson Space Center is primarily responsible for flight experiments, the Kennedy's Biomedical Lab provides the local support. However, as stated above, there are many challenges facing KSC workers that gain the attention of this lab in the measurement of the problem and the selection and testing of

countermeasures. These include respiratory protection, whole body suits, hearing protection and heat stress, among many others.

### **Noise Environment Advances**

The Kennedy Space Center is the primary launch and landing site for the Nation's space program. In this operational role, there are many operational work environments that challenge occupational noise standards and limits. Don Doerr states that, "The Lab has recently been testing the noise environment of the Category IV Propellant Handler's Ensemble (PHE) by using in-situ methods." Kennedy has a number of adverse noise environments in which workers must use communication gear. While these workers can be provided effective forms of hearing protection to meet important Occupational Safety and Health Administration (OSHA) requirements, these forms of hearing protection have not always been practically assessed in the actual work environment. Kennedy's Biomedical Laboratory has now established state-of-the-art test methods using off-the-shelf equipment and the Category IV Propellant Handler's ensemble is the first operational piece of personal protective equipment to be tested. In this project, the two available communications headsets were evaluated: The Snoopy Communication Carrier and the wire frame headset. Because OSHA requires the institution of "engineering controls" prior to protective measures, two newly proposed techniques were evaluated: the smooth bore helmet supply hose and the modified orifice air restrictor in the inlet fitting.

Another interesting component of this work is to assess how much of the adverse noise from the work site is actually transmitted out via radio and intercom circuits to destinations such as the firing room. A study was conducted on the noise reduction module using digital processing techniques for high noise operational environments – SCAPE. There are many noisy operational environments at KSC where communications gear must be used for coordination, procedural guidance, and safety. While most of these environments have specified the requirement for hearing protection for workers, there is no provision for the transmission of environmental noise via communications systems such as the Operational Intercommunication System – Digital (OIS-D) or radio circuits. Consequently, environmental noise is transmitted to all others on communications circuits that degrade the quality, intelligibility and usability. The intent of the project was to detect and filter out the environmental noise using digital signal processing techniques. In this project, two candidate environments were tested: (a) the Category IV (houseline supplied) SCAPE (self-contained atmospheric protective ensemble) and (b) the M-113 armored personnel carrier used for astronaut rescue at pads 39A and B. A prototype DSP module and amplifier breadboard was constructed and inserted into the microphone line before the OIS-D interface. A sound system was fed into the Bruel and Kjaer Head and Torso Simulator (HATS) mouth speaker and that provided reproducible signal source for the microphone and data was recorded.

On the M-113 – the Bruel and Kjaer Head and Torso Simulator (HATS) was moved to the armored personnel carrier and outfitted with the Fire Rescue TCH helmet. This helmet has electronic noise cancellation capability on the receiver side, but the microphone is exposed to the excessive sound levels inside the tank. These levels approach 117 dB when the carrier is underway. The tests demonstrated that the use of digital signal processing techniques will detect and filter any repetitive or monotonous signals and allow dynamic and unique (i.e. voice) information to pass through.

## **A Better Understanding of Heat Stress**

Recently, as stated at the beginning, the lab has been checking out a Koolvest™ manufactured by Respirex, Inc., London, UK. When Kennedy workers are loading propellants they are wearing a SCAPE suit, which is used for protection from toxic rocket propellants. The environmental control units (ECUs) in these Category I SCAPE suits use liquid air to provide both breathing air and some cooling to the wearer; however, summer ambient conditions often exceed the cooling capacity of the ECU. To help remedy this problem, the lab decided to test the efficacy of the Koolvest™. Dr. Kenneth D. Cohen, a Physiologist and Biomedical Engineer, conducted the studies and found that the Koolvest™ provided significant cooling to both SCAPE-suited subjects and (non SCAPE suited) test conductors. The subjects had significantly smaller rises in core temperature wearing the Koolvest™ and lost significantly less weight (i.e., sweated less) wearing the Koolvest™. The Koolvest™ contains inserts of nontoxic phase change material (PCM) that remove heat from the vest wearer. The particular nontoxic phase change material (PCM) that remove heat from the vest has a freezing/melting point of 65 degrees F., which makes the vest more comfortable and physiologically suitable compared to other (ice) cooling vests available. Packets of solid PCM in the Koolvest™ remove heat from the wearer, which drives the PCMs transition from a solid to a liquid. This is usually well in excess of 1 hour, depending on work load and ambient conditions. Dr. Cohen stated that twelve research volunteers (11 males, 1 female) performed various tasks representative of SCAPE operations in a 110 °F environmental chamber. Volunteers completed the SCAPE work protocol twice, one with the Koolvest™ and once without (control condition). Conditions were randomized and tests were separated by at least seven days. Subjects were instrumented to measure 5 skin temperatures, body core temperature, and heart rate. Subjects were weighed immediately before and immediately after testing to measure weight lost through sweating. Oxygen, carbon dioxide, and pressure were measured inside the SCAPE suit helmet. The SCAPE-suited subjects had significantly smaller rises in core temperature and lost significantly less weight (i.e., sweated less) when they wore the vest. Test conductors (who were exposed to the same hot temperatures) also benefited from wearing the vest.

For a small facility, this lab has achieved big results. Don says that they have been helped in the past by the Technology Programs and Partnerships Branch who have provided seed funding via the Center Director Discretionary Fund that resulted in the SCAPE improvements, the Liquid Air pack, and other protective apparatus. The ultimate objective is to improve the health and safety of all personnel working at KSC, with the hope that much of this development can be transferred to industry and thus benefit the nation as well as the space program.

## **Reference**

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